Each of the distillation units comprises a process microchannel **310** and an adjacent liquid channel **330**. These are the same as discussed above. The rows **303** of distillation units **302** are separated by cross-flow heat exchange channels **304** positioned between the rows **303**. Heat exchange manifolds **305** and **306** distribute heat exchange fluid to the heat exchange channels **304**. The heat exchange manifold **305** includes heat exchange fluid inlets **307**. Heat exchange manifold **306** includes heat exchange fluid outlets **308**. This embodiment provides the advantage of avoiding the use of interleaved heat exchange channels while still providing the required temperature profile. In this embodiment each heat exchange channel provides thermal communication with a plurality of process microchannels **310** and liquid channels **330**. The microchannel distillation unit **300**C employs a separate heat exchange manifold for each layer of heat exchange channels. Alternatively, a common manifold for a plurality of or all of the heat exchange channels can be used.

[**0075**] Each of the process microchannels (**310**, **420**, **425**, **420***a*, **425***a*, **510**, **610**, **710**) may have a cross section that has any configuration, for example, square, rectangular, circular, oval, trapezoidal, etc. Each of these process microchannels has at least one internal dimension of height or width of up to about 10 mm, and in one embodiment from about 0.05 to about 10 mm, and in one embodiment about 0.001 to about 5 mm, and in one embodiment about 0.05 to about 2 mm, and in one embodiment about 0.05 to about 1.5 mm, and in one embodiment about 0.05 to about 1 mm, and in one embodiment about 0.05 to about 0.5 mm. The other internal dimension of height or width may be of any value, for example, it may range from about 0.01 cm to about 2 cm, and in one embodiment from about 0.01 to about 1 cm, and in one embodiment from about 0.1 to about 1 cm. The length of each of the process microchannels **310** may be of any value, for example, it may range from about 1 to about 200 cm, and in one embodiment about 1 to about 50 cm, and in one embodiment about 2 to about 10 cm. The length of each of the process microchannels **420**, **425**, **420***a*, **425***a* may be in the range from about 0.1 to about 1000 mm, and in one embodiment about 1 to about 100 mm.

[**0076**] The gap between the opposed walls **318** and **319** in each of the microchannel distillation sections (**370**, **370***a*, **370***b*, **370***n*-**2**, **370***n*-**1**, **370***n*) may range from about 0.1 to about 20 mm, and in one embodiment from about 1 to about 10 mm. The width of each microchannel distillation section may range from about 1 to about 100 mm, and in one embodiment about 2 to about 50 mm, and in one embodiment about 5 to about 10 mm. The height of each microchannel distillation section (**370**, **370***a*, **370***b*, **370***n*-**2**, **370***n*-**1**, **370***n*) from one capture structure (**372**, **372***a*, **372***b*, **372***n*-**2**, **372***n*-**1**, **372***n*) to the next capture structure (for example, from capture structure **372** to capture structure **372***a*) may range from about 2 to about 100 mm, and in one embodiment about 2 to about 75 mm, and in one embodiment about 2 to about 60 mm, and in one embodiment about 2 to about 40 mm, and in one embodiment about 2 to about 25 mm, and in one embodiment about 2 to about 15 mm, and in one embodiment about 2 to about 10 mm, and in one embodiment from about 5 to about 10 mm.

[**0077**] The height of each of the microchannel distillation sections (**410**, **410***a*) for microchannel distillation unit **400** from one vapor inlet/outlet to the next, for example, from inlet/outlet **450** to inlet/outlet **452**, may be in the range from about 0.1 to about 1000 mm, and in one embodiment about 1 to about 100 mm.

[**0078**] The interior wall (**371**, **371***a*, **371***b*, **371***n*-**2**, **371***n*-**1**, **371***n*) may be formed of a material that is suitable for establishing a wetted wall. These materials enhance the adherence of the liquid phase to it as the liquid flows along the interior wall as a thin film. Examples of useful materials include steel (e.g., carbon steel, and the like); monel; inconel; aluminum; titanium; nickel; platinum; rhodium; copper; chromium; brass; alloys of any of the foregoing metals; polymers (e.g., thermoset resins); ceramics; glass; composites comprising one or more polymers (e.g., thermoset resins) and fiberglass; quartz; silicon; or a combination of two or more thereof. The wetted wall material may be in the form of a coating or layer of one of the foregoing materials on the surface of microchannel wall **318**, the coating or layer having a thickness of about 0.1 to about 500 microns, and in one embodiment about 0.1 to about 250 microns, and in one embodiment about 0.1 to about 100 microns, and in one embodiment about 0.1 to about 50 microns, and in one embodiment about 0.1 to about 10 microns. In one embodiment, the interior wall may be partially wetted with intermittent or continuous non-wetted portions. The thin film flowing along the interior wall, as indicated by arrows **373**, **373***a*, **373***b*, **373***n*-**2**, **373***n*-**1** and **373***n* may have a thickness of about 0.1 to about 500 microns, and in one embodiment about 0.1 to about 250 microns, and in one embodiment about 0.1 to about 150 microns, and in one embodiment about 0.1 to about 75 microns, and in one embodiment about 1 to about 50 microns.

[**0079**] The capture structure (**372**, **372***a*, **372***b*, **372***n*-**2**, **372***n*-**1**, **372***n*) may comprise any structure that captures liquid and permits vapor to flow through it. The capture structure may assist the movement of liquid contacting the capture structure to and through the liquid exits (**374**, **374***a*, **374***b*, **374***n*-**2**, **374***n*-**1**, **374***n*) to the wicking region **332**. The capture structure may comprise a wire mesh or cones that project from the liquid exits (**374**, **374***a*, **374***b*, **374***n*-**2**, **374***n*-**1**, **374***n*). The capture structure may comprise inverted cones, liquid-nonwetting porous structures having a pore size gradient with pore sizes getting larger toward the wicking region **332**, liquid-wetting porous structures having a pore size gradient with pore sizes getting smaller toward the wicking region **332**, and/or fibers such as found in demisters or filter media. The capture structure may comprise one or more of sintered metal, metal screen, metal foam, and polymer fibers. Mechanisms for capturing dispersed liquid particles include impingement (due to flow around obstructions), Brownian capture (long residence time in high surface area structure), gravity, centrifugal forces (high curvature in flow), or incorporating fields, such as electrical or sonic fields, to induce aerosol particle motion relative to the flow field.

[**0080**] In one embodiment, the capture structures (**372**, **372***a*, **372***b*, **372***n*-**2**, **372***n*-**1**, **372***n*) may comprise perforated foil, for example, a perforated foil in the form of expanded tetrahedrally configured filaments. Examples include Delker expanded screens such as 10 AL 16-125 P and 5 Cu 14-125 P. These screens can have one or two orders of magnitude higher permeability than conventional woven screens. In